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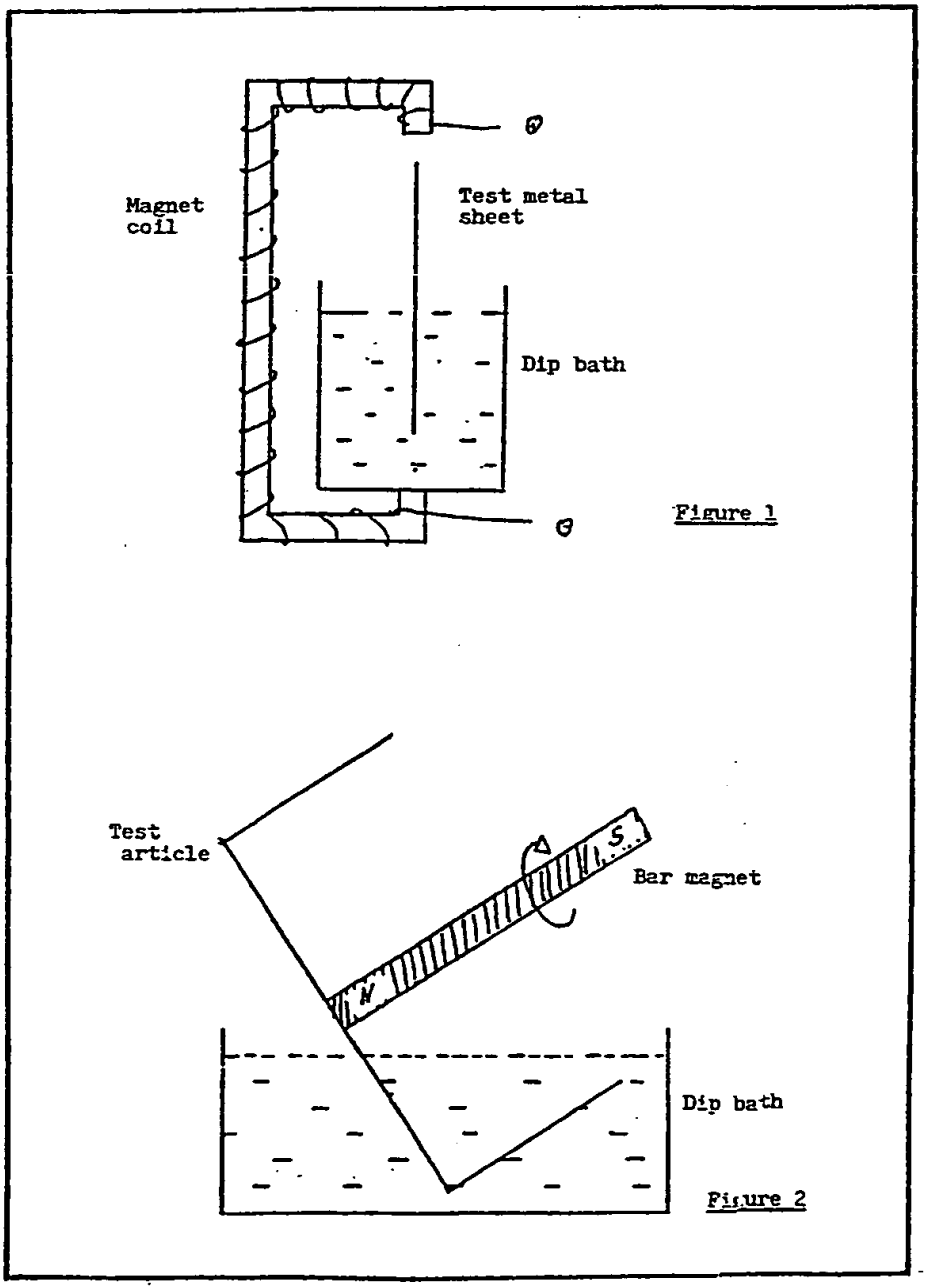
# (54) Process for Lacquer-coating Iron and Steel

(57) The process according to the invention relates to the coating of iron and steel articles with lacquers in a magnetic field. Lacquers are employed which contain at least one ferromagnetic pigment. An increased magnetic flux in the region of edges, corners, points or the like has the effect of producing flawless (i.e. pore-free) coverage with lacquer in these regions. Increased deposition, compared with that or other surface parts, can also be achieved. The process is particularly important for the lacquer-coating of automobile bodies, machines and steel furniture.

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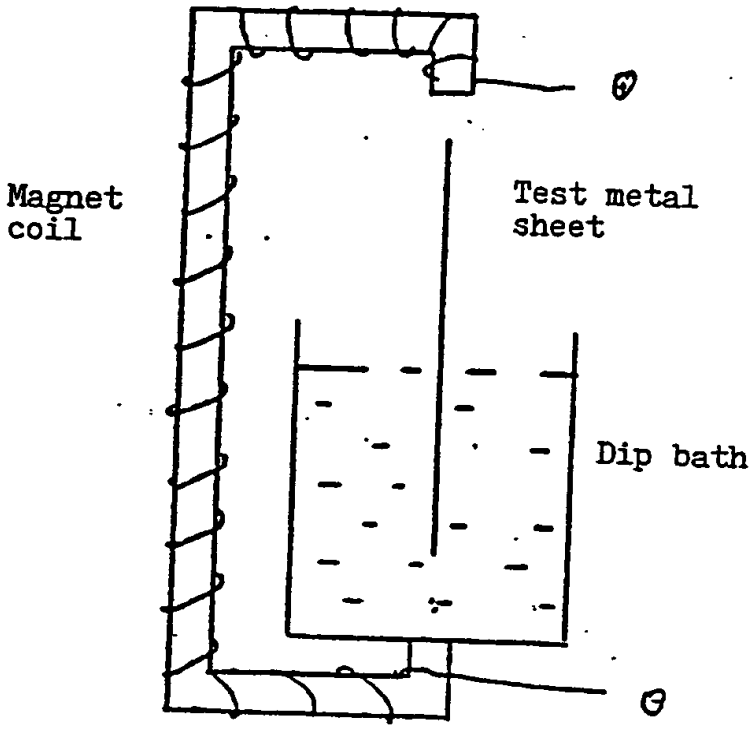


Figure 1

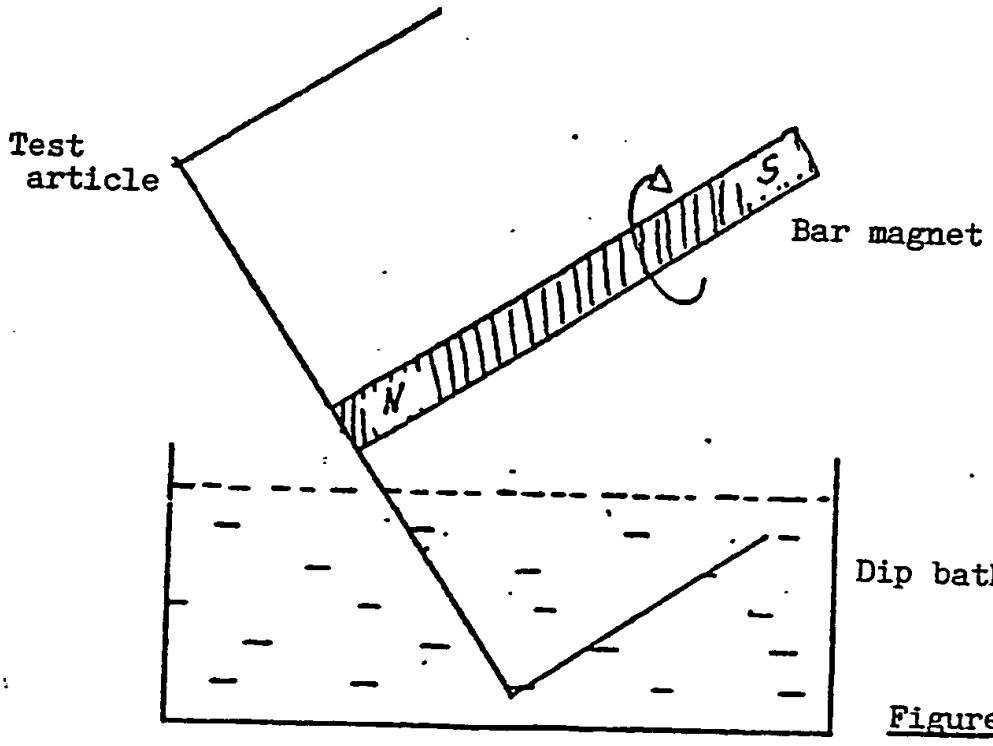


Figure 2

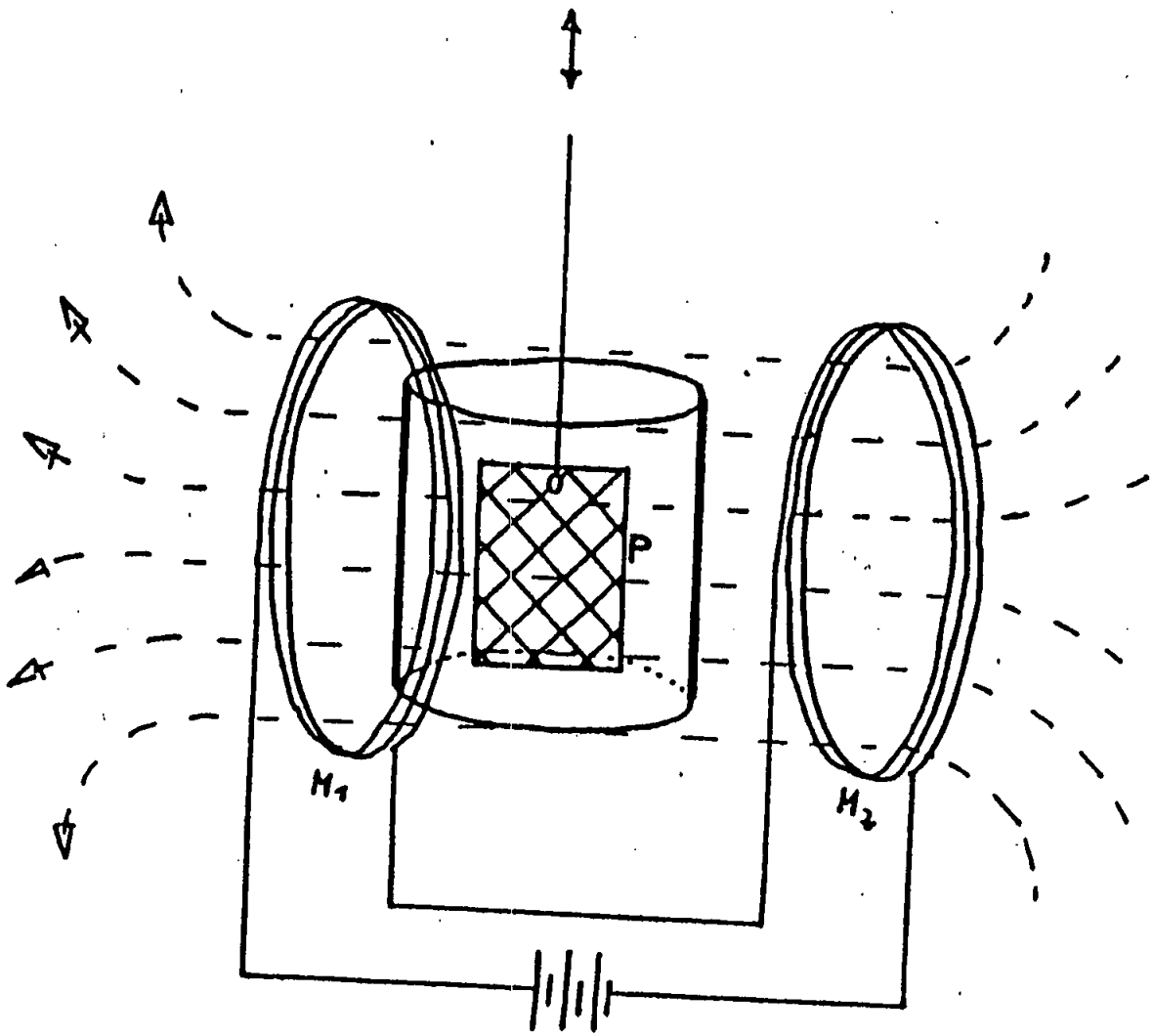


Figure 3

SPECIFICATION

# Process for Lacquer-Coating Iron and Steel

The present invention relates to a process for lacquer-coating iron and steel.

When applying liquid lacquers, especially aqueous lacquer suspensions, a difficulty which arises, if the electrophoresis process is not employed, during application by the dipping or flooding process, is that of depositing the laquer in a sufficiently thick layer and without defects arising (i.e. pore-free) in the region of edges, corners, points and the like. This defective covering of the edges is particularly pronounced in the case of primer coating, i.e. when applying the first coat of an anti-corrosion lacquer (of the primer), and in the case of the lacquer-coating of iron and steel has disastrous consequences in the form of increased corrosion and rusting.

Attempts have already been made to solve the problem of the defective coating of the edges by adding thixotropic agents to the lacquer and, especially in the case of aqueous systems, by relatively high concentrations of emulsifier in the formulations. It is true that it was possible slightly to improve the covering of the edges in this way, but neither measure can be used for high grade baking lacquers since both measures severely impair the levelling of the lacquer applied.

The object of the invention is to find a process for lacquer-coating iron and steel articles which does not have the cited disadvantages of the known coating processes. Application of the lacquer should be effected in a controlled manner, either uniformly or in a manner which also enables the lacquer to be deposited in a thicker layer in the region of sharp edges and corners than on the other surface parts of the article. By means of this thicker layer, subsequent corrosion in the region of sharp edges, which in itself is particularly susceptible to corrosion, should be substantially excluded or reduced.

The invention relates to a process for coating iron or steel articles with lacquers with improved, i.e. uniform and, if desired, intensified, deposition of the lacquer in the region of edges, corners, points or the like, by dipping, flooding or spraying, which comprises a) using a lacquer which contains at least one ferro-magnetic pigment, if desired in addition to other conventional lacquer pigments and/or lacquer additives, and b) carrying out the coating in a magnetic field in such a way that the edges, corners, points or the like are located in the region of increased magnetic flux $\geqq 10$ m T.

According to the invention, the magnetic field of an electromagnet is preferably used. Magnets which can be used are not only those which have an iron core but also coreless magnets, which, thus, are built up virtually only of the magnet coils. In principle, permanent magnets are also suitable if they meet the condition in respect of the magnetic flux.

In general, for carrying out the process according to the invention, the article to be coated is introduced into the magnetic field and fastened. However, it is also possible to use a procedure in which the article to be coated with lacquer is itself part of a magnet or, as a result of close contact with a magnet, is virtually part of the magnet.

Suitable ferromagnetic pigments for the process according to the invention are in particular the iron oxide coloured pigments, such as black iron oxide, brown iron oxide and red iron oxide. However, nickel powder is also suitable.

According to the invention, the concentration of the ferromagnetic pigment in the lacquer employed is between 5 and 70% by weight, based on the binder of the particular lacquer; the binder is to be understood as meaning the base resin, which can be mixed with the corresponding curing agent. The lacquer can also contain several ferromagnetic pigments at the same time.

The process according to the invention can be used with virtually all lacquer-coating methods and thus, for example, also with powder-coating processes. Preferably, however, it is used for those methods in which liquid lacquers, especially aqueous systems, are employed. The technical effect of the invention is particularly pronounced when aqueous lacquer suspensions are used. In principle, suitable lacquers are those which contain thermoplastics as the base resins and also those in which the base resins are curable synthetic resins. Base resins based on thermoplastics are, for example, saturated polyesters, PVC, polyvinyl propionate, polyamides and polyacrylates. Curable synthetic resins are in particular epoxide resins and phenol-formaldehyde resins, urea-formaldehyde resins and melamine-formaldehyde resins, and these can be combined with components necessary for curing. Both the base resins based on thermoplastics and the base resins based on thermosetting synthetic resins can also contain several resins of the particular resin category at the same time.

The process according to the invention can be used, for example, for the lacquercoating, and especially for the priming with primers, of automobile bodies, machines and equipment and parts thereof, and of steel furniture. It is preferably used with the dipping and flooding methods of application. In principle, however, it can also be used for methods of application which do not have any great industrial significance, for example in spraying or in spreading by means of a brush.

The invention is illustrated in more detail with the aid of the following Examples.

## Example 1

650 g of solid bisphenol A epoxide resin (epoxide content = 0.6 mol/kg), 350 g of a saturated polyester (acid number about 50, melting point about 95°C), 650 g of red iron oxide (BAYER, type 130 F) and 5 g of a flow control agent (Modaflow, MONSANTO) are melted together in a Co-kneader (BUSS AG, Switzerland) and, after cooling, the mass is

ground to a particle size of about 100 $\mu$m. A suspension with a solids content of about 40% by weight is prepared from this powder by adding water and this suspension is then ground further in a bead mill to a particle size of about 10 $\mu$m. After adding 50 g of glycerine, a phosphated ("bonderised") steel sheet is dipped into the suspension, the dip bath being provided with an electromagnet as shown in Figure 1. After a few seconds, the metal sheet coated with lacquer is withdrawn from the suspension and dried for 10 minutes at room temperature. It is then baked at 200°C for 10 minutes. After baking, the metal sheet has a flawless, and in particular pore-free, coating of lacquer on all edges and surfaces.

**Example 2**

The procedure of Example 1 is repeated except that the magnetic poles are reversed (reversal of the direction of current in the magnetic coil). The result is equally as good as in Example 1.

**Example 3 (comparison example)**

The procedure of Example 1 is repeated except that the dipping operation is carried out in the absence of the artificial magnetic field (current switched off in the magnet coil). The edges of the baked metal sheet are exposed in parts and have many pores.

**Example 4**

A mixture of 600 g of a solid bisphenol A epoxide resin (epoxide content = 1.0 mol/kg), 5 g of "Uresin B" (flow control agent from Hoechst), 300 g of benzoguanamine-methylol methyl ether, 200 g of $TiO_2$ and 300 g of black iron oxide (BAYER, type 216 F) is processed, as in Example 1, to an aqueous suspension. After adding 1.5 g of amino coconut fatty acid oxethylate and 50 g of polypropylene glycol to the 40% suspension, the formulation thus formed is used in the following way to coat a deep-drawn tin-plate mug.

A bar magnet is placed centrally on the base of the mug, as shown in Figure 2, with the south pole facing upwards, so that the north pole adheres firmly to the base of the mug and the latter virtually becomes part of a larger composite magnet. The mug connected to the magnet is now inclined (as can be seen from Figure 2) and lowered into the lacquer suspension. The entire article is rotated about the longitudinal axis of the magnet, so that the mug is coated with lacquer by the dipping method except for a central region, which is not intended to be lacquer-coated. This procedure is followed by drying and baking in the manner described in Example 1. A uniform film with pore-free coverage of the edges results.

**Example 5 (comparison example)**

The procedure of Example 4 is repeated except that the iron oxide pigment is replaced by the same amount of $TiO_2$. The resulting lacquer film is in the main likewise uniform. However, the edges of the test metal sheet are exposed in parts and have many pores.

**Example 6**

A direct current source is applied to two coils $M_1$ and $M_2$ in accordance with Figure 3, in such a way that an electric current flows in the same direction through both coils. A dip bath is placed in the magnetic field which forms between the coils and this bath is filled with a coating formulation according to Example 1. A test metal sheet (P) made of steel is lowered into the dip bath and raised again. After customary pre-drying and baking of the coating, the metal sheet shows flawless and in particular pore-free coverage of all edges and surfaces with lacquer.

**Example 7**

The same experiment is carried out using an electrical alternating voltage and this leads to the same result.

**Claims**

1. A process for coating iron or steel articles with lacquers with improved, i.e. uniform and, if desired, intensified, deposition of the lacquer in the region of edges, corners, points or the like, by dipping, flooding or spraying, which comprises a) using a lacquer which contains at least one ferromagnetic pigment, if desired in addition to other conventional pigment, if desired in addition to other conventional lacquer pigments and/or lacquer additives, and b) carrying out the coating in a magnetic field in such a way that the edges, corners, points or the like are located in the region of increased magnetic flux $\geqq$ 10 m T.

2. A process according to claim 1, wherein a lacquer is used which contains one or more ferromagnetic pigments in a total concentration of 5 to 70% by weight, based on the binder.

3. A process according to claim 1 or 2, wherein an aqueous lacquer system is employed.

4. A process according to claim 3, wherein an acqueous lacquer suspension is employed.

5. A process according to any one of the preceding claims, wherein a lacquer is employed which contains solid lacquer particles of a thermoplastic or a mixture of thermoplastics.

6. A process according to any one of claims 1 to 4, wherein a lacquer is employed which contains lacquer particles of a curable synthetic resin or of a mixture of curable synthetic resins.

7. A process according to claim 6, wherein the lacquer particles of the lacquer employed consist of a curable synthetic resin from the series comprising epoxide resin, phenol-formaldehyde resin, urea-formaldehyde resin and melamine-formaldehyde resin, if desired in combination with components required for curing, or of a corresponding mixture of resins.

8. A process according to any of the preceding claims, wherein coating is carried out by the dipping or flooding method.

9. A process according to claim 7, wherein coating is carried out by the dipping method.

10. A process for coating iron or steel articles

with lacquers, substantially as described with reference to any of Examples 1, 2, 4, 6 and 7.

11. Iron or steel articles coated with lacquers, when produced by a process claimed in any of the preceding claims.

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